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Characterization of earth, air lime and air lime-earth mortars with natural fibers for renders and plasters

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Earth-based mortars have been used since prehistoric times

The oldest known uses were for plastering storage bins, for covering and filling vegetal sheltering structures and, with sedentarization, for plastering masonry walls

Nowadays earth mortars are recognized as high standard mortars for plastering

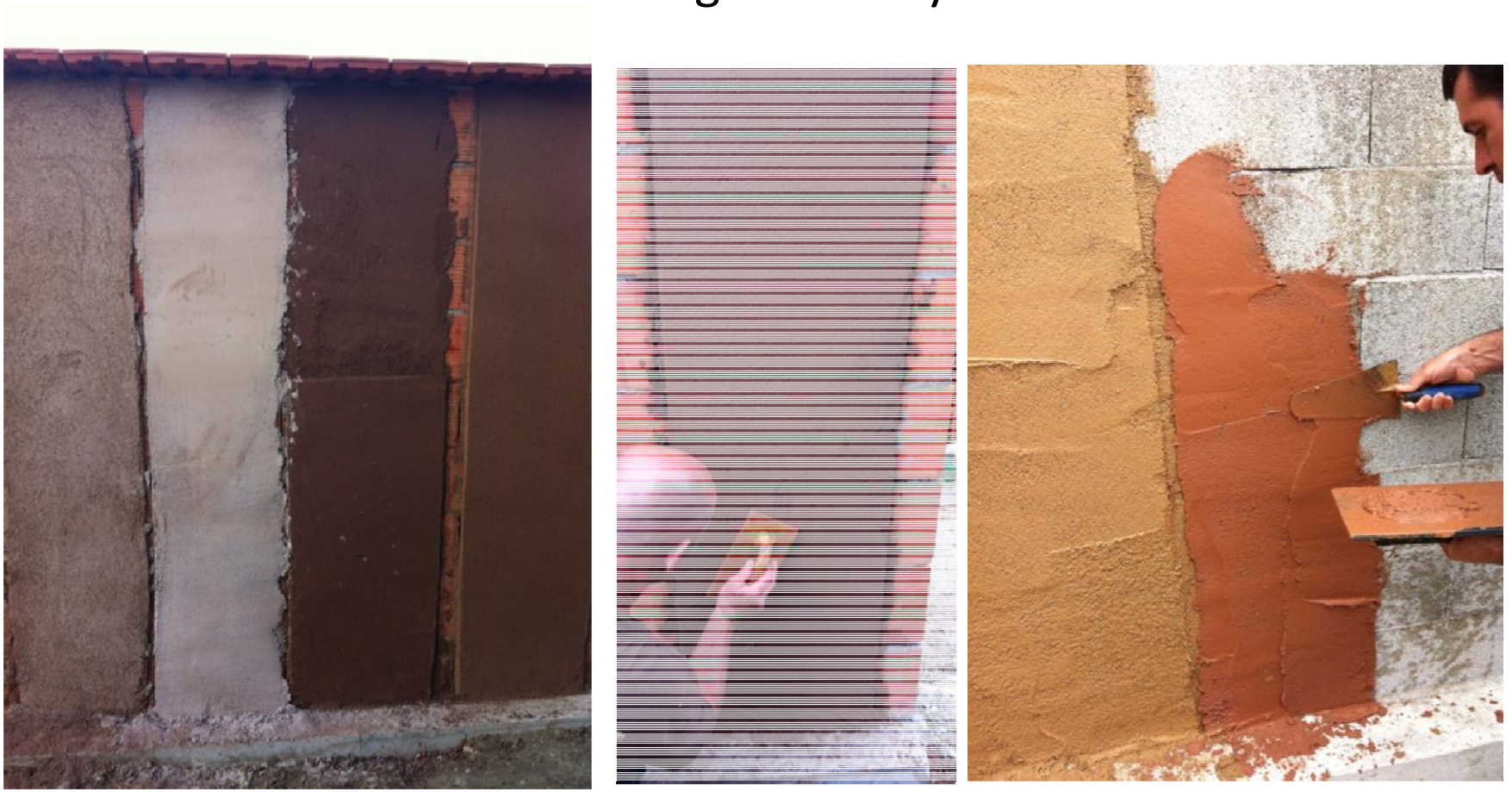
Earth-based mortars often have fibers to control shrinkage

Alcott test – for shrinkage optimization

Nets and vegetal elements can also be used to reduce crack susceptibility, mainly over different supports

Earth and/or air lime based mortars are used for strawbale masonry renderings (exterior) and plasterings (interior)

Earth-based mortars offer a large diversity of colors and textures

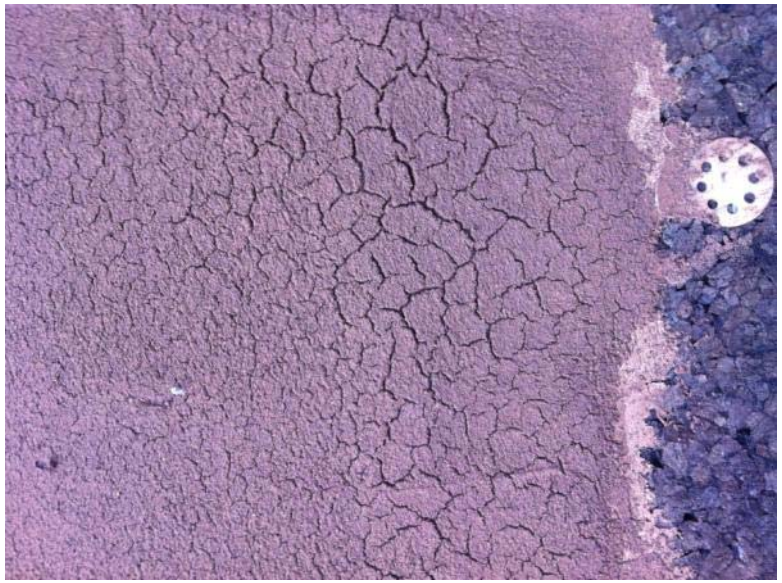


Plaster panels made with the same earth but with different additions and finishings

Premix earth mortar with vegetal fibers applied by projection on experimental walls

The plaster surface

Example of a thin layer of earth mortar over ICB that did not behave efficiently



Example of an earth mortar applied unprotected from rainfall – loss of clay particles

Earth mortars behave efficiently when protected from rainfall

Apart from aesthetic and ecologic aspects, they contribute for hygroscopic equilibrium and air quality in interior environments

Natural fibres content may have to be balanced with mould and fungus development susceptibility

When rainfall resistance is requested, air lime can be added and **air lime-earth blended mortars** are formulated

Some advantages (and desadvantages) of earth mortars change…

Air lime-based mortars can be analyzed based on EN 1015 **standards**

Earth-based mortars without addition of binders can be analyzed following DIN 18947: 2013

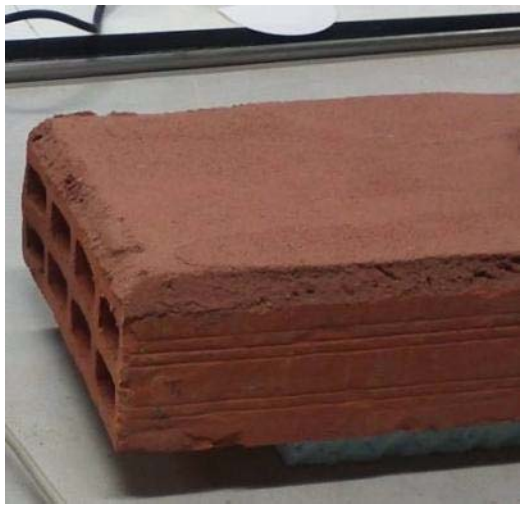
- salts content
- linear shrinkage
- bulk density
- strenght – dynamic modulus of elasticity, flexural, compressive and adherence (to support)
- capillary absorption
- drying and water vapour permeability
- resistance to abrasion, to freeze-thaw and to salts
- absorption-desoption / hygroscopicity
- behaviour under fire
- …

Characterization of mortars in the **fresh state**

- Flow table consistency / workability
- Air content
- Water retention
- …

For the characterization of hardened mortars, **specimens** have to be prepared:

- Prismatic 40 x 40 x 160 (mm)
- Circular with 20 mm thick
- With a mortar layer over a support
- …



Hardened mortars lab characterization (some examples)

For mortars with lime, it depends on age and curing conditions

Dynamic modulus of elasticity

Thermal condictivity

Flexural and compressive strenght

Characterization of mortars with natural fibers for plastering and rendering

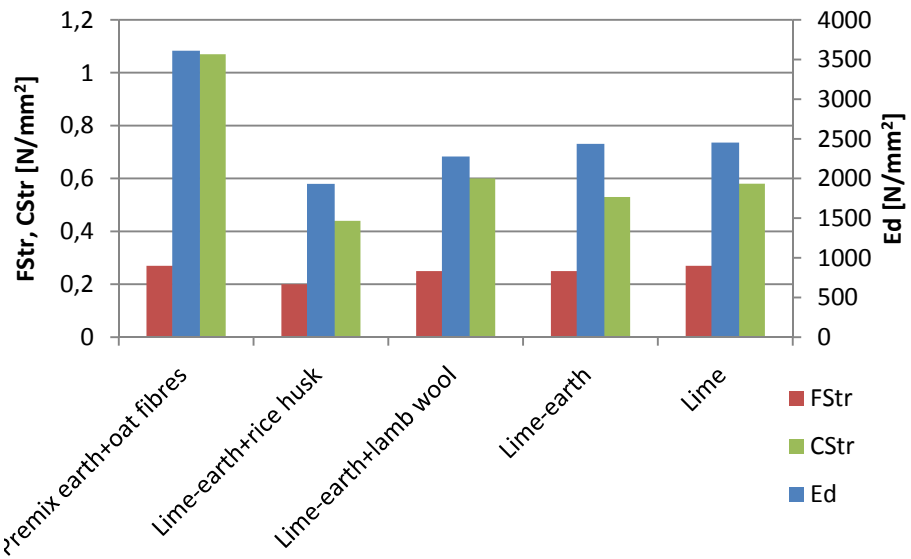
In air lime-earth mortars, earth is substituting lime; all mortars have sand

Dynamic modulus of Elasticity, Flexural and Compressive Strength, Moisture Buffer Value, Capillary Coefficient and Drying Rate

Mortar	Ed [N/mm²]	FStr [N/mm²]	CStr [N/mm²]	MBV [m².% RH]	CC [kg/(m².min^{0,5})]	DR [kg/(m².h)]
Premix earth+oat fibres	3610	0,27	1,07	1,59	-	-
Air lime-earth+rice husk	1933	0,20	0,44	0,40	7,59	0,20
Air lime-earth+lamb wool	2277	0,25	0,60	0,52	5,74	0,20
Air lime-earth	2436	0,25	0,53	0,66	4,70	0,66
Air lime	2453	0,27	0,58	0,68	6,49	0,68

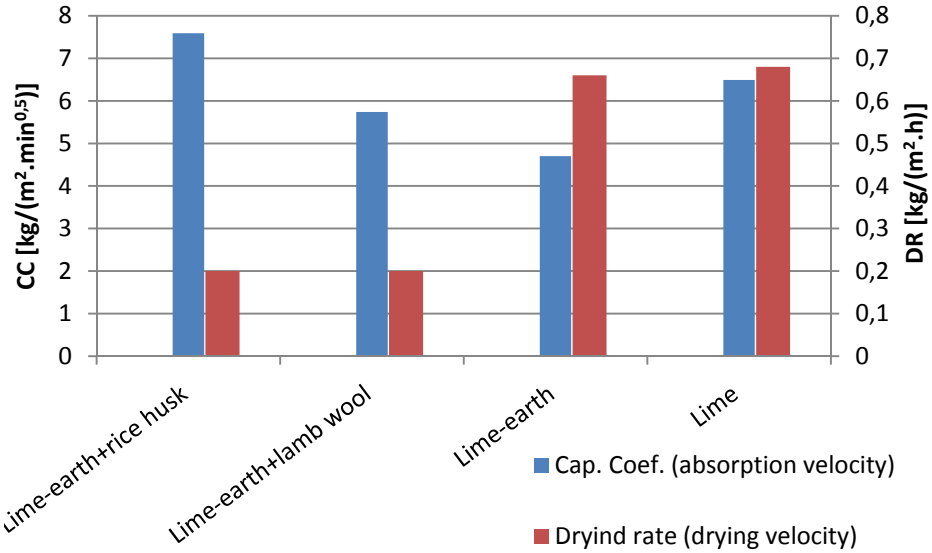
Characterization of mortars with natural fibres for plastering and rendering

In air lime-earth mortars, earth is substituting lime; all mortars have sand



•The FStr is lower for the mortar with rice husk

• The premix mortar achieve a CStr (and Ed) much higher than the lime mortar

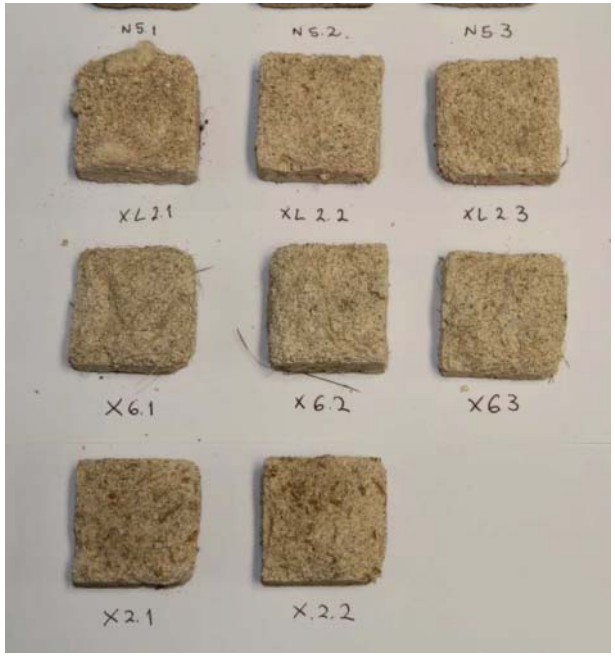


• Lime-earth mortar with the lowest CC and the highest for rice husk mortar

• Rice husk and lamb wool mortars with slower initial drying

• Capillary and drying not (yet) determined for the premixed earth (without binder) mortar

Characterization of air lime, earth and air lime-earth mortars, with natural fibers, for **biological growth**



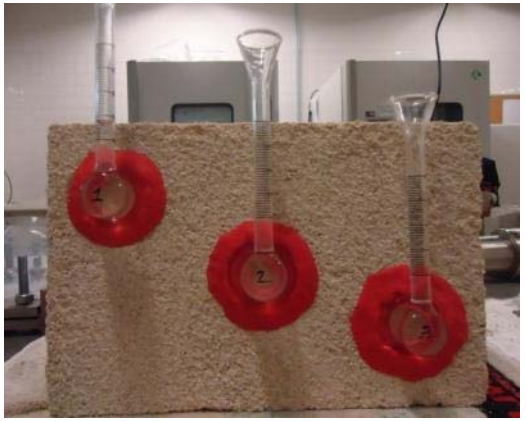
Credits Lina Nunes

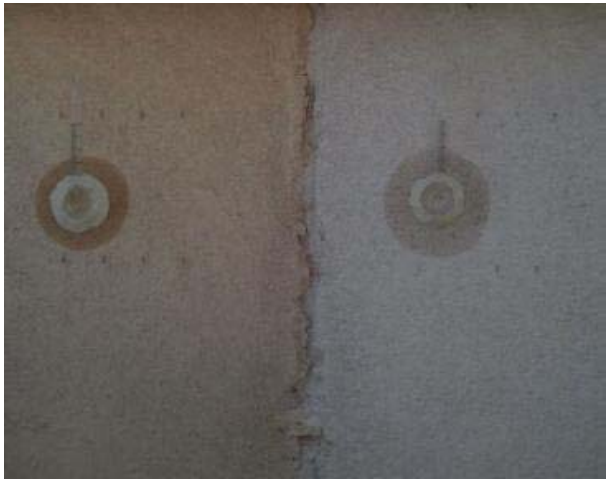
Non destructive and *in situ* characterization of mortars over a support

US velocity

Superficial hardness by durometer and sclerometer

Water absorption by Karsten tubes





Thank you !